Mini Review

USE OF ARTIFICIAL INTELLIGENCE IN HISTOPATHOLOGICAL INTERPRETATION - A MINI REVIEW

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Abstract

The accuracy of artificial intelligence (AI) in medicine, particularly pathology, has improved significantly, but little is known about how much these algorithms will influence pathologists' decisions in practice. Most developing-country laboratories lack resources such as whole-slide scanning and digital microscopes. They are unable to manage massive volumes of data due to severe budgetary restrictions and a lack of resources. Because of these limitations, valuable data cannot be kept or used appropriately. This review attempts to describe the role of AI in histopathological interpretation.

Keywords: Artificial intelligence, AI, Pathology, Histopathology, Interpretation

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INTRODUCTION

Artificial intelligence (AI) has made significant advancements in various fields of healthcare, including histopathological interpretation. AI is an umbrella terminology for the different strategies a computer can employ to think and learn like a human. Pathological AI models have progressed from expert systems to conventional machine learning (ML) and deep learning (DL).

Histopathology involves the microscopic examination of tissue samples to diagnose diseases such as cancer. AI can be utilized in several ways to assist pathologists in this process, improving accuracy, efficiency, and patient care.

AI has shown great potential in the field of histopathological interpretation, revolutionizing the way pathologists analyze tissue samples and make diagnoses.

REVIEW:

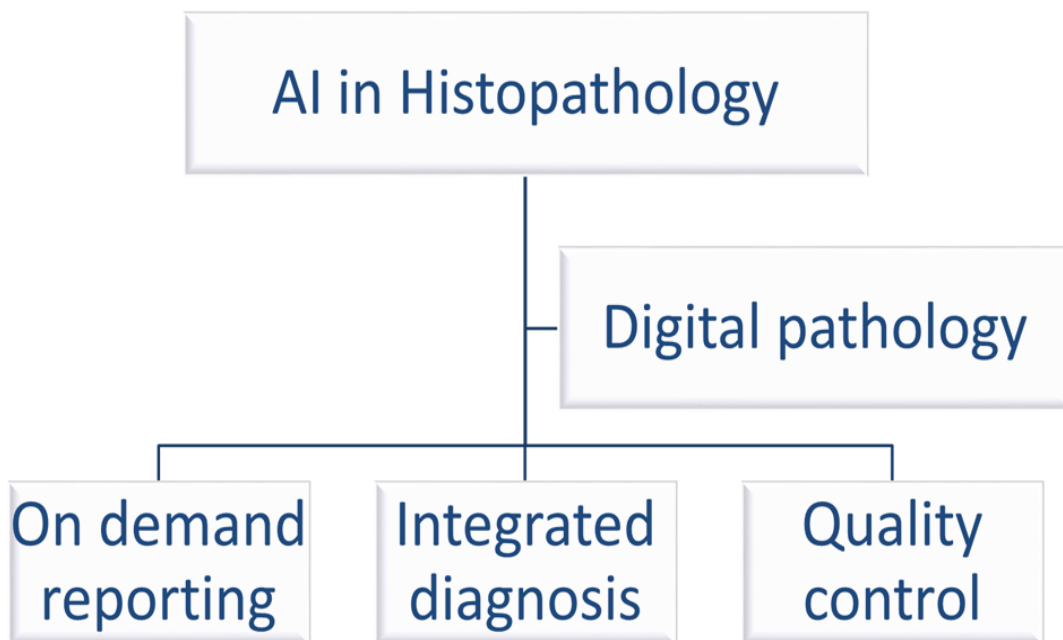Here are some key applications of AI in histopathology (**Figure 1):**

Figure 1: Summary of AI in Histopathology

Automated Tissue Analysis:

AI algorithms can automatically analyze digitized histopathological slides, identifying and segmenting tissue structures, such as nuclei, cytoplasm, and extracellular matrix. This automated analysis can help reduce the time-consuming manual tasks performed by pathologists.

Image Classification, Image Analysis, Pattern Recognition, and Diagnosis:

AI models can be trained to classify histopathological images based on patterns and features. AI algorithms can analyze digital histopathology images and detect patterns and features that may indicate the presence of specific diseases. For example, they can differentiate between normal and abnormal tissue, classify different types of tumors, or determine the grade and stage of cancer. These AI models can aid pathologists in making accurate and consistent diagnoses.

Deep learning techniques, such as convolutional neural networks (CNNs), can be trained on large datasets to identify and classify different tissue structures, cellular morphology, and abnormalities.

Detection of Anomalies and Features:

AI algorithms can detect subtle or rare features in histopathological images that might be challenging for human observers to identify. They can help identify specific cellular and tissue characteristics associated with various diseases, leading to early detection and personalized treatment plans.

Automated tumor detection and segmentation:

AI can help automate the detection and delineation of tumors within histopathology images. By leveraging computer vision algorithms, AI models can identify and outline tumor regions, aiding pathologists in accurate tumor quantification and assessment of tumor margins.

Prognostic and Predictive Analysis:

AI models can analyze large datasets of histopathological images, patient records, and clinical outcomes to identify correlations and patterns that can be used to predict disease progression, treatment response, and patient survival. This information can assist pathologists and oncologists in making more informed decisions and providing personalized patient care.

Quality Control and Standardization:

AI algorithms can contribute to quality control processes in histopathology laboratories. AI can play a crucial role by automatically flagging potential errors or inconsistencies in histopathological analysis. By ensuring standardized interpretation and reducing inter-observer variability, AI can improve the accuracy and reliability of diagnoses with standardization in reporting.

Education and Training:

AI-based platforms can be used for educational purposes, allowing pathologists to access a vast repository of annotated histopathological images. These platforms can aid in training and continuous professional development, helping pathologists improve their diagnostic skills and stay updated with the latest research and advancements in the field.

Workflow optimization and triaging:

AI tools can streamline the workflow in histopathology laboratories by automating routine tasks, such as slide scanning, sorting, and prioritization. AI algorithms can assist in triaging cases based on urgency, complexity, or the presence of critical findings, allowing pathologists to focus on more challenging or critical cases.

It's important to note that while AI can assist pathologists in histopathological interpretation, it is not meant to replace human expertise. Pathologists play a crucial role in reviewing and validating AI-generated results, ensuring patient safety and accurate diagnoses. The collaboration between pathologists and AI systems has the potential to enhance diagnostic accuracy, efficiency, and overall patient care in histopathology.

These articles provide a starting point for understanding the use of AI in histopathological interpretation and can serve as references for further exploration of the topic.

1."Artificial intelligence in histopathology: From image analysis to automated diagnosis" by Ehteshami Bejnordi et al. (Nature Reviews Cancer, 2017): This article provides a comprehensive overview of AI techniques applied to histopathology, including image analysis, tumor detection, and prognosis modeling. It discusses the challenges, opportunities, and potential impact of AI in improving cancer diagnosis and patient care.

2."Artificial intelligence in digital pathology—new tools for diagnosis and precision oncology" by Johan Lundin et al. (Nature Reviews Clinical Oncology, 2020): This review article explores the use of AI in digital pathology, focusing on its applications in cancer diagnosis and precision medicine. It discusses the potential benefits, limitations, and future directions of AI-driven histopathological interpretation.

3."Deep learning in histopathology: Pathology image analysis beyond the visible spectrum" by Humayun Irshad et al. (Journal of Pathology Informatics, 2019): This article highlights the role of deep learning algorithms in analyzing histopathology images, including the use of multi-spectral and hyperspectral imaging. It discusses the challenges associated with implementing AI in histopathology and provides insights into potential solutions.

4."Artificial intelligence in digital pathology: A roadmap to routine use in clinical practice" by Liron Pantanowitz et al. (The Journal of Pathology, 2019): This paper presents a roadmap for integrating AI into routine clinical practice in digital pathology. It discusses the challenges related to data acquisition, standardization, validation, and regulatory considerations. The article also provides recommendations for successful implementation and future developments in the field.

5."Applications of artificial intelligence in histopathology" by Andrew Janowczyk et al. (Laboratory Investigation, 2020): This article explores various applications of AI in histopathology, including image analysis, tumor classification, and prognostication. It discusses the potential impact of AI in improving diagnostic accuracy, reducing inter-observer variability, and aiding in therapeutic decision-making.

Limitations of AI:

However, there are still some issues with AI implementation, such as algorithm validation and interpretability, computing systems, the skepticism of pathologists, clinicians, and patients, as well as regulators and reimbursements. Despite this, artificial intelligence (AI) technology is not widely used as a medical device and has not been approved by a regulatory authority. As a result, certain improvements in the development process are still required for the implementation of AI in real-world histopathology practice.

CONCLUSION

Measures should be taken to infuse trust in implementing AI among pathologists and it's incorporating it into their daily routines. Efforts at specialized centers should be directed towards minimizing burden rather than enhancing accuracy. AI Designers must also consider usability and how AI will be integrated into pathologists' workflow. Data sharing between countries will help in developing a robust system that will ultimately benefit mankind.

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Conflicts of interest

There are no conflicts of interest

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